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ORIGINAL ARTICLES.

I.—Notes on British Dinosaurs. Part II: *Polacanthus*.

By Dr. Francis Baron Nopcsa.

(PLATE XII.)

NEXT to *Hypsilophodon*[1] it was *Polacanthus* which attracted my attention. A careful study soon showed that, after the death of the animal, the remains of some Crocodilian had accidentally become commingled with this Dinosaur. Besides this, some pieces, namely, the back part of a skull and a cervical, showed remarkably *Iguanodon*-like characters, and the same is also true of the pubic bone described by Seeley in 1892 as belonging to *Polacanthus*.

As I intend pointing out further on, and as has also already been done by Seeley, *Polacanthus* was constructed essentially after the *Struthiosaurus* plan, and this is the reason why this *Iguanodon*-like basi-occipital has to be removed from the *Polacanthus* remains.

For the removal of the pubic bone from the genus *Polacanthus*, similar arguments can be brought forward.

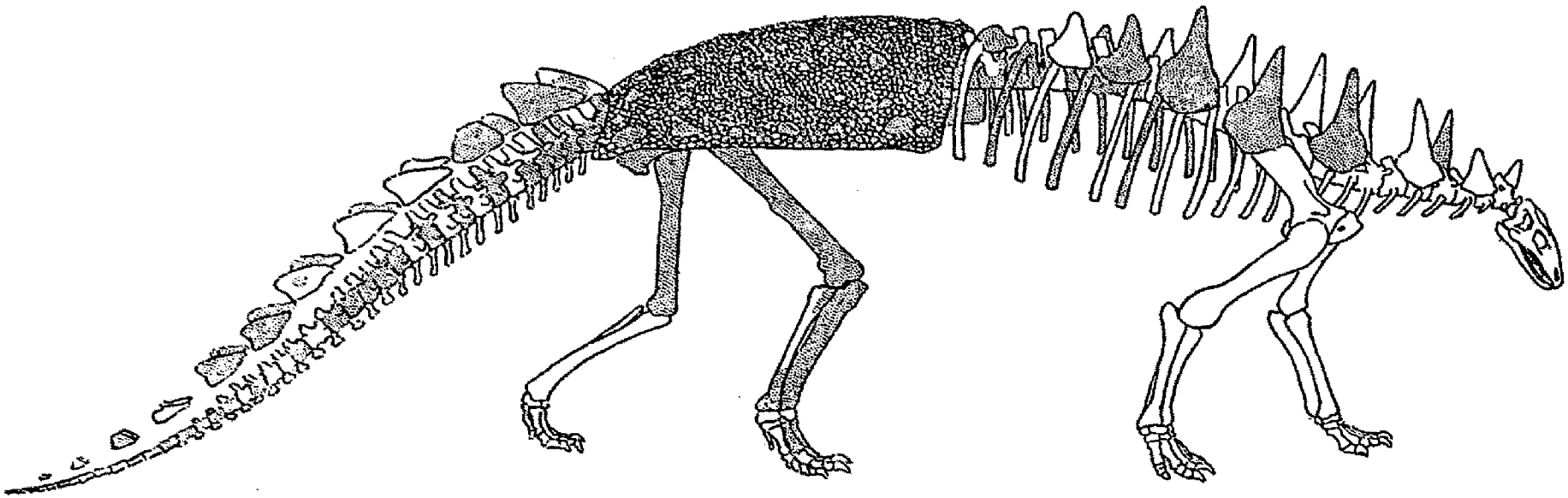
(1) The ischium and pubis are two closely correlated bones, and as the ischium of *Polacanthus* is totally different from that of *Iguanodon* the same was to be expected as to the pubis.

(2) Both ischium and pubis are correlated with locomotion, and as *Iguanodon* was a bipedal and *Polacanthus*, on the contrary, a quadrapedal animal, we again cannot expect *Polacanthus* to have an *Iguanodon*-like pubis.

Since the so-called *Polacanthus* pubis differs from *Iguanodon* only by being somewhat shorter,[2] and agrees very well with the *Iguanodon*-like basis cranii and cervical vertebræ, I think it may quite well belong to an *Iguanodon*-like animal, and not to *Polacanthus*.

[1] For *Hypsilophodon*, see Geol. Mag., May, 1905, pp. 203–208.

[2] Even this *may* be due to fracture.



Reconstruction of the skeleton and bony dermal armour of *Polacanthus Foxi*, Hulke.

Wealden: Isle of Wight. Set up in the Geological Department, British Museum (Natural History).

After these preliminary remarks one can determine as belonging to *Polacanthus*—

4 free dorsal vertebræ,
11 co-ossified vertebræ, forming together with ribs and dermal armour the lumbo-sacral shield,
19 caudal vertebræ,
7 right, 3 left } ribs,
2 femora,
1 right tibia with fragment of fibula,
1 right (?) metatarsal bone,
3 left, 5 right } dorsal spines,
8 left, 6 right } upper caudal plates,
some plates of uncertain position,

and besides these numerous fragments. Comparing these data with those given by Fox, one remarks that only some metatarsals, phalanges, and dermal spines are missing.

Vertebræ.

Although the vertebræ have been described by Hulke, still I think some characters have not been clearly brought out; moreover, a comparison between the vertebræ of *Polacanthus* and other Dinosaurs is still entirely wanting. To Hulke's description of the foremost dorsal vertebræ scarcely anything has to be added, except the facts that the fractured surface of the spinous process shows a quadrate outline, that the neural canal shows lateral compression, that the præ- and postzygapophyses are remarkably near the median line of the body, and that the postzygapophyses project rather far backwards.

Taking into consideration that only 4 free dorsal vertebræ are present, while one can count not less than 7 ribs belonging to the right side, and that between the first and second of these ribs a considerable difference is observable, it is obvious that *Polacanthus* possessed at least 8 free dorsal vertebræ, so that together with the 5 anchylosed lumbodorsal vertebræ the back of *Polacanthus* consisted of at least 13 vertebræ, and assuming the presence of at least 7 cervical vertebræ, this accords well with the number of vertebræ in *Scelidosaurus* (22), while in the reconstruction of *Stegosaurus* 24 vertebræ are given. In *Triceratops* still more vertebræ seem to have been present. At all events the back of *Polacanthus* must have attained a length of 90–100 cm. This dimension will prove of great value in the reconstruction of the dermal armour.

Compared with other Dinosaurs it is, as already mentioned, *Struthiosaurus* to which the dorsal vertebræ of *Polacanthus* show the most remarkable resemblance, and this is the reason why near Fig. 1, representing a dorsal vertebra of *Polacanthus*, a sketch of a *Struthiosaurus* vertebra is also given. There seems, furthermore, some affinity to exist with the vertebræ of *Omosaurus*, while there are no points of resemblance between our animal and the North

American *Triceratops*, the vertebræ of the latter being much more abbreviated and transversely expanded. The dorsal vertebræ of the highly interesting *Stegoceras* and *Stereocephalus* are yet practically unknown.

Compared with *Scelidosaurus* and *Stegosaurus* there exists a remarkable difference, for in the former the diapophyses are given off at a much lower point than in *Polacanthus*, while *Stegosaurus* seems to exaggerate this elevation of the diapophyses which separates *Polacanthus* from *Scelidosaurus*. In a future paper on *Dacenturus* I intend to come back once more to this question, and I shall try to show why this elevation of the neural arch (visible also in fossil South American sloths) was developed. Here I only wish to draw attention to the fact that in a recent paper (Ann. Mag. Nat. Hist., 1904) Professor Seeley tries to explain this elevation by the upward pressure of the lungs against the neural spines. The anchylosis of the lumbar vertebræ, a unique feature among Dinosaurs, strongly reminds one of the same character in *Glyptodon*,

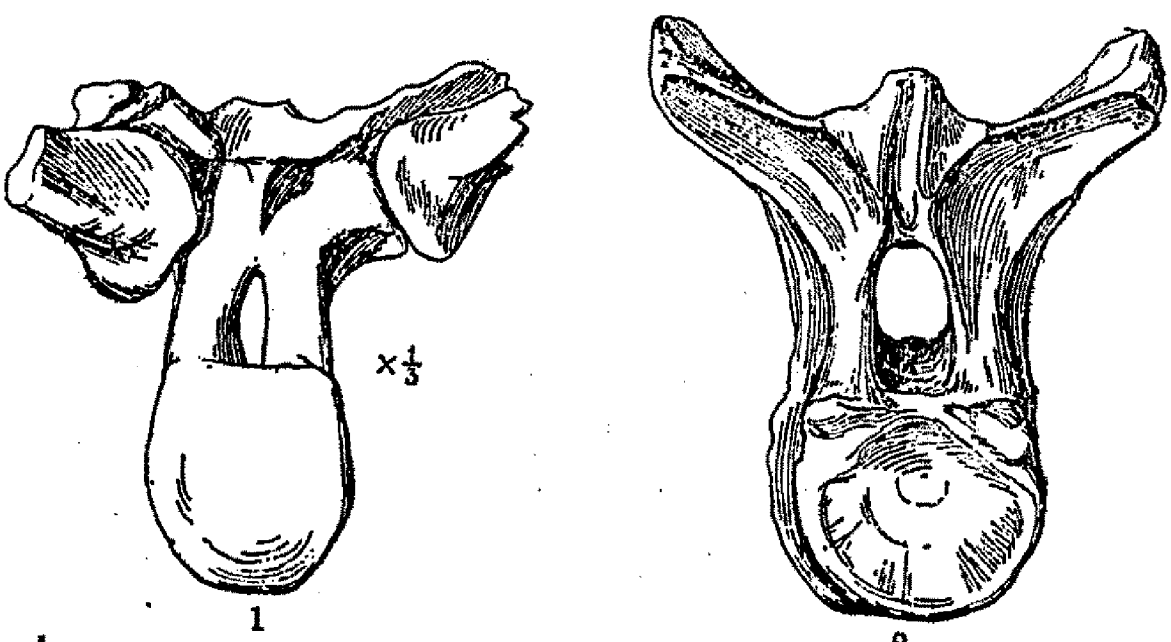


Fig. 1.—Dorsal vertebra of *Polacanthus*, posterior view.
,, 2.—Dorsal vertebra of *Struthiosaurus*, posterior view.

and may be explained as subserving the very same purpose. Hulke's description is equally satisfactory for the sacral as for the lumbar region of the body. The inter-vertebral position of all sacral ribs is, however, a fact worth while mentioning once more.

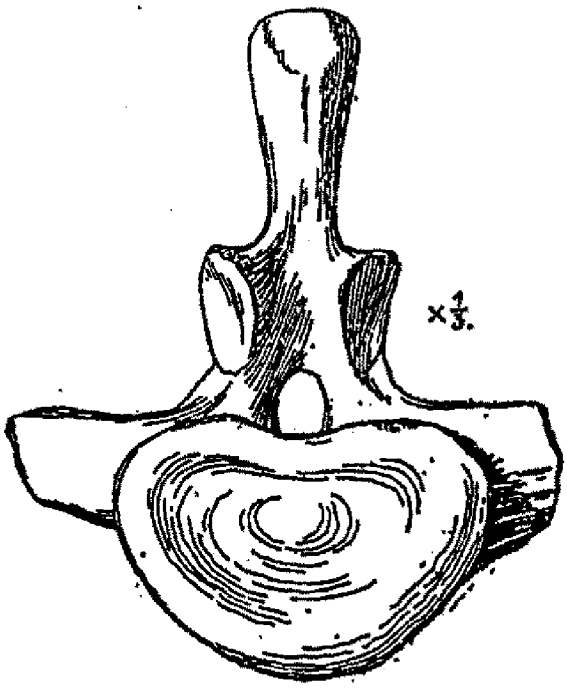
There does not seem to exist any especial widening out of the neural canal in the sacral region, as recorded for *Stegoceras*, and also visible in *Dacenturus* (*Omosaurus*).

Concerning the caudal vertebræ, there is, first of all, the curious fact to be noted, that while Fox originally mentioned 20 vertebræ and I myself managed to count 19 distinct centra Hulke mentions only 13, so that for some time 6 were apparently missing.

As Hulke points out, the proximal caudal (Fig. 3) are much broader than high, and have, in consequence of the neural canal being partly lodged in the centrum, a somewhat depressed heart-shaped outline. At the same time they are much shorter than the

dorsals and lumbars, and in consequence have an abbreviated appearance. The processus transversi are given off from the centrum, and are pointed nearly horizontally outwards. A similar abbreviated and expanded structure of the centrum may be observed on some, not yet described, *Dacenturus*-like vertebræ in the Havre Museum. I therefore think the original shape of the proximal caudals in *Polacanthus* has been only slightly disfigured by pressure. The neural spine is not very long, but very thick, and the præ- and low præ- and postzygapophyses do not project far out over the articular surfaces of the centrum.

The median caudals differ by having a less depressed, less expanded, and more elongate centrum, and the diapophyses directed downwards and outwards. The neural canal is much smaller, the chevron bone articulated nearly entirely with the hind part of the centrum, there being scarcely any impression for its articulation on the anterior margins.



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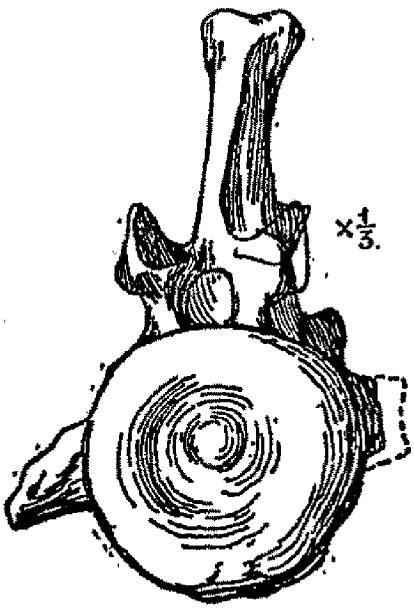

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Fig. 3.—Proximal caudal of *Polacanthus*, posterior view.
„ 4.—Middle caudal of *Polacanthus*, anterior view.

Further back, towards the end of the tail, the vertebræ become still more elongate, and the front articular surface, which was slightly concave in the anterior and median caudals, becomes decidedly convex. The posterior surface remains concave throughout the whole vertebral column. In Figs. 4 and 5 sketches of middle and posterior caudals are given.

Until now only one chevron bone of *Polacanthus* has been detected, but this one is quite characteristic. The top view shows a nearly quadratic section, and at its distal end its thickness is about twice that of its antero-posterior dimensions. Both rami are exceedingly strong, and in accordance with the general massive structure of the tail.

There is a striking resemblance between the root of the tail of *Polacanthus* and that of the gigantic *Megatherium*; the rest of the tail has, however, been reconstructed after the *Hylæosaurus* pattern.

Femur.

The femur of *Polacanthus* differs by its proximal and distal expansion very markedly from the same bone in *Dacenturus*, *Stegosaurus*, or even, though less so, from *Scelidosaurus*, and can only be compared with *Struthiosaurus* from the Gosau formation. Among mammalia it is not with the Proboscidea that the *Polacanthus* femur should be compared, but rather with *Dinoceras*, and this is of no small interest, since it is the Proboscidean femur that the femur of the Stegosaurians and Sauropoda seems to have imitated. In my forthcoming *Dacenturus* paper I intend to ventilate also this question which, to a certain extent, has already been noticed by the late Professor Hatcher.

Dermal Armour.

As Hulke mentioned in 1881 and 1887, one can distinguish in the dermal armour of *Polacanthus* flat plates which are united by synostosis and form a buckler covering the sacrum and the lumbar region; besides, there are small button-like round scutes which, as in *Hylæosaurus*, belong to the end of the tail; then there are keeled

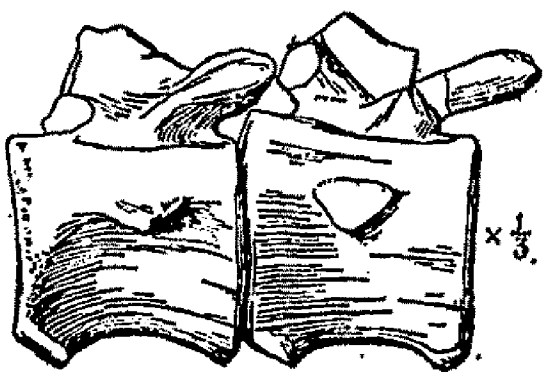

Fig. 5.—Two of the posterior caudals of *Polacanthus*, side view.

high roof-like scutes which also belong to the caudal region, further on heavy spines rising from a flat triangular base, and besides this large oval plates which show a rounded keel near the middle. It can be seen that in this particular the dorsal ossifications of an animal show a great amount of specialisation.

The sacrolumbar buckler is well known, being figured and described by Hulke in a supplementary note in 1887. It is to be noticed that the anterior margin is thinned out, thus indicating that the abrupt anterior end is not due to fracture.

Some other points have, however, till now entirely escaped attention. In Hulke's figure in 1887, plate 9, the last lumbar ribs are drawn as if a thinning out towards the margin were to be expected. This is, as an inspection showed, and as Seeley already pointed out in his sketch of the *Polacanthus* pelvis, not the case, but the ribs terminate nearly at the median dorsal margin of the ilium, or are extended somewhat beyond and above the præacetabular process of the ilium. As Professor Seeley has already pointed out, the structure of the ilium bears a remarkable resemblance to the same part in *Omosaurus* and *Stegosaurus*, but I do not think it is dessication, as Seeley modestly puts it, to which we owe since 1892 the visibility of the

iliac bone in *Polacanthus*, but I rather think we owe this simply to the Professor's keen eye and intimate knowledge of Dinosaurian structure. Until now, however, though already mentioned and figured by Hulke, no attention has been paid to the fact that across all the dorsal and sacral ribs ossified tendons (ligaments ossified) extend which show a considerable amount of disturbance, and thus clearly prove that they have not been co-ossified either with the superimposed dorsal armour or with the underlying ribs. This alone shows, apart from all other physiological considerations, that right and left from the median dorsal line the dorsal armour was not co-ossified with the ribs, and if co-ossification did occur it could only have happened on the surface of the ilia and along the summits of the neural spines. Through this indication there appears to exist a still greater resemblance between the so-called '*Danubiosaurus*' bone of Gosau and *Polacanthus*, because also in that one a median empty space seems to have separated the underlying rib-like bone. As Professor Seeley has likewise mentioned, the iliac bone extends laterally somewhat beyond the lumbosacral shield.

Besides the dorsolumbar shield Hulke distinguished in his second *Polacanthus* paper three types of dermal armour. The roof-like plates Hulke supposed to be situated *à cheval* above and below the hæmal and neural spines, while the spines were believed to be situated somewhere on the thoracic region, and flat shields are supposed, according to Fox's interpretation, to have covered the belly.

Since the dermal covering of no Stegosaurid animal is yet perfectly known, and the figure Marsh gives of *Scelidosaurus* does not seem quite correct in this regard, it seems at first rather difficult to decide these questions, but having been able to investigate, besides *Polacanthus*, both *Hylæosaurus* and *Scelidosaurus*, and having fitted in *Polacanthus* numerous new pieces together, I am able to assert that the roof-shaped scutes formed two rows right and left of the neural spines of the caudal vertebræ, and that the highest spines belong to the scapular region.

Before dealing, however, with this problematical armour it is necessary to consider first the nearly perfectly preserved mail of *Scelidosaurus*. On the body of *Scelidosaurus* one can trace out quite distinctly seven rows of dermal ossifications, which show that the back of this animal was covered by a median row of keeled scutes, on the sides of which a smaller row is visible. In this second row the tubercles increase the nearer we approach the sacrum. Laterally of this second row we can distinguish on each side two rows of scutes converging forwards, in each of which the scutes gradually augment in height the more they approach the scapular region, so that meeting at the scapula these two rows at last form only one row of rather tall spine-like ossifications. A good idea of the way they augment in height towards the scapula is given in the otherwise not quite correct reconstruction of *Scelidosaurus* published in the edition of the popular guidebook of the British Museum.

In the sacral region of *Scelidosaurus* the dermal ossifications are

strongly displaced, and it is only in the caudal region that we find them comparatively in order.

On the middle part of the tail one can clearly distinguish three roof-like plates, one placed on each diapophysis of the centrum and one on the neurapophysis of the arch. Further back one can only observe two roof-like, somewhat asymmetrical plates placed laterally of the neurapophysis and above the diapophysis, thus allowing space for the musculus lateralis caudæ. A thicker plate is visible in one place laterally of the chevron bone. In *Diracodon*, *Stegosaurus*, and *Dacenturus* (*Omosaurus*) we know that the end of the tail was protected by a double row of spines, while the anterior caudals and all the other vertebræ supported one median row of high plates, which in consequence of their abrupt posterior margin were pointed somewhat backwards and formed an acute dorsal ridge.

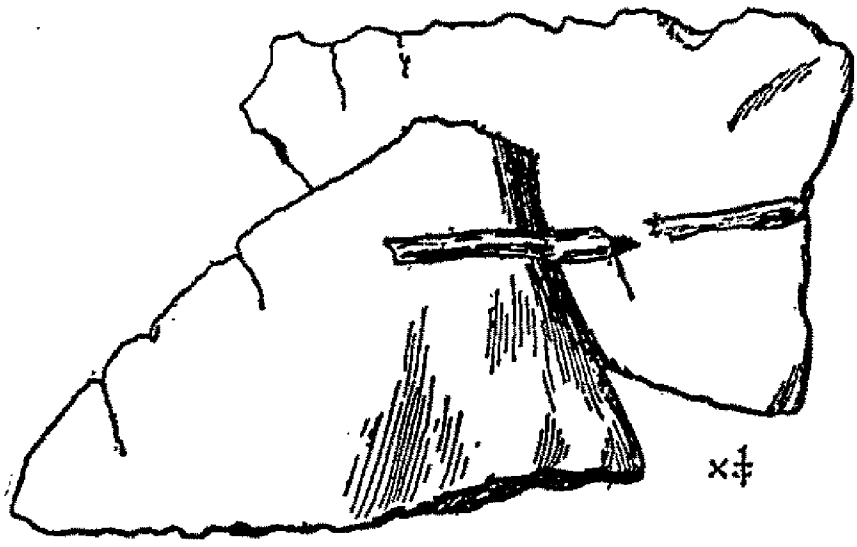

Fig. 6.—One pair of dermal caudal plates of *Polacanthus* (preserved united in matrix), side view.

The probably complex armour of the Ceratopsidæ is altogether unknown, and the same is true for *Acanthopholis* and *Struthiosaurus*. Besides *Scelidosaurus*, *Hylæosaurus* is the only European armoured Orthopodous Dinosaur in which the armour is still partly *in situ*, and though somewhat disturbed, one can notice that this Dinosaur possessed at least two rows of lofty spines which, beginning directly behind the head, increase rapidly in height and attain their maximum development and sharpness in the scapular region. This reminds one to a certain degree of the armour of the Iguana tuberculata. The lumbar region of *Hylæosaurus* is nearly unknown, and in the tail only button-like ossifications seem present.

Turning back to *Polacanthus*, the piece figured by Hulke and fragments which I succeeded in uniting prove that some of the roof-like plates and button-like pieces belong to the armour of the tail. By placing all the roof-like plates in one row beside the caudal vertebræ it soon, however, became evident that this was *not* their natural position, for the row they formed in this way is just about twice as long as the entire series of caudal vertebræ.

This circumstance drew my attention to numerous facts not yet

mentioned. Two such caudal spines measure each 21 cm., two others 19, and so on. Besides this the peculiar features of the two largest, the two next, and so on, is always similar, so that arranging the spines according to the colour and size we get a series attaining the presumed length of the tail of *Polacanthus*. This alone would be enough to prove that the plate-like scutes were arranged in pairs along the tail, but besides this and the comparison with *Scelidosaurus* there is yet another point to prove it.

By carefully uniting some fragments I managed to bring two plates of equal size still united with matrix in close contact with an underlying vertebra, and this piece, as well as the unsymmetrical character of two uncrushed pieces (which prove to be the before-mentioned last pair of scutes), shows that the roof-like plates could not have been arranged in any other manner than

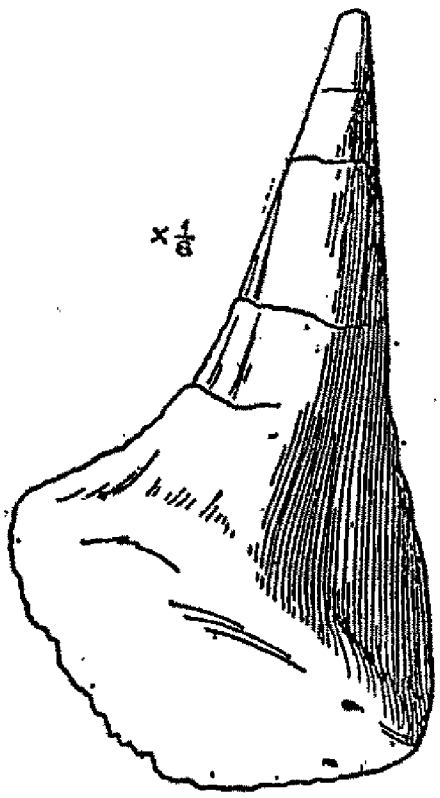

Fig. 7.—Anterior dorsal dermal spine of *Polacanthus*, interior (median) view.

indicated in the reconstruction. Thus the whole top of the tail of *Polacanthus* was covered with two rows of diverging, broad, sharp-edged plates, while the button-like ossicles were distributed between them so as to cover the empty spaces.

In consequence of their great antero-posterior length each of the main scutes was not fixed merely on one but on two or three caudal vertebræ, thus restricting, together with the ossified tendons, the movement of the powerful tail.

Having finished with the tail and its armour, the question where to place the dermal spines (Fig. 7) of *Polacanthus* became quite easy. They could neither belong to the tail nor to the lumbosacral region. They come, therefore, evidently from the anterior part of the body. They are asymmetrical; according to their size they can be arranged in pairs, and the rows thus formed attain a length of 150 cm. Ribs and free dorsal vertebræ show that the thoracic

region of *Polacanthus* measured 90–100 cm., and is thus considerably shorter than the space which these spine-like ossifications cover. Supposing, however, that the spines extended anteriorly right to the back of the skull, as they do in *Hylæosaurus*, and at least 7–8 cervical vertebræ to have been present, this agrees with the length indicated by the double row of spines, and in consequence one cannot help rebuilding *Polacanthus* in a *Hylæosaurus*-like manner.

The coexistence of large, asymmetrical, round, thick, feebly keeled plates, together with the spines in question, shows furthermore that the other, probably more inferior rows of the dermal covering were not formed by spines, but by elements of another type; these are the single pieces that one cannot place *in situ*.

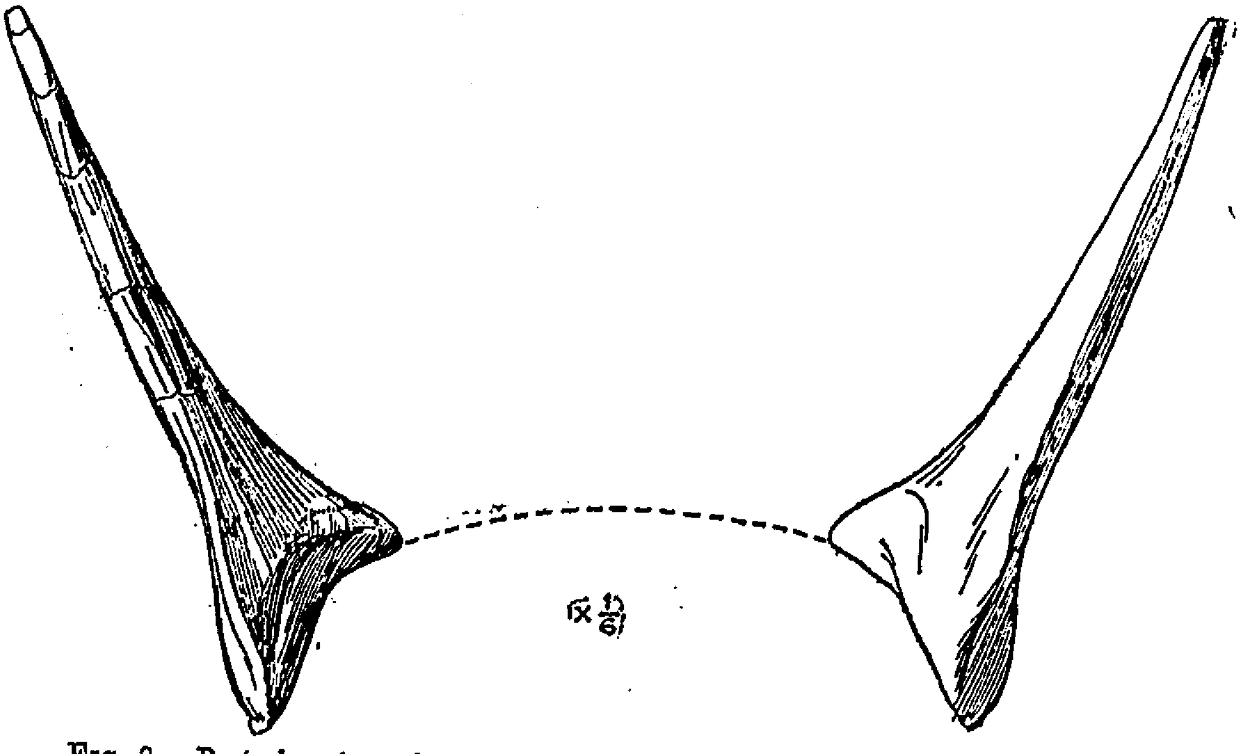

Fig. 8.—Posterior view of a pair of anterior dorsal dermal spines of *Polacanthus*.

Conclusion.

The conclusions drawn from the fresh study of *Polacanthus* are expressed in the reconstruction of the animal as carried out by the 'mason formatori' of the British Museum, Mr. Barlow, under Dr. A. S. Woodward's and my superintendence; and this reconstruction afforded the basis for the Plate accompanying this paper. Through this reconstruction Dr. Hulke's and the Rev. W. Fox's general views about *Polacanthus* are nearly completely in accord. *Polacanthus* was an animal of low stature, whose height at the rump did not exceed three feet. Its strongly marked bones and their large joints speak of its immense muscular power, whilst the shortness of its limbs and the anchylosis of the lumbar vertebræ, welding the loins and the sacrum into a long inflexible rod, give probability to its having been a slowly moving vegetable-feeder. With these characteristics one might venture to add the remark that *Polacanthus* was a sort of Glyptodon among the Dinosaurs.

EXPLANATION OF THE PAGE-PLATE XII.

The shaded parts of the drawing indicate the parts actually preserved; the rest has been reconstructed according to the evidence afforded by *Struthiosaurus*.